# NAVAL POSTGRADUATE SCHOOL

## MONTEREY, CALIFORNIA

# THESIS

**USING AN EXPERIMENTAL APPROACH TO IMPROVING THE SELECTIVE REENLISTMENT BONUS PROGRAM**

by

William J. Norton

June 2007

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The Selective Reenlistment Bonus program is a powerful force management tool designed to increase retention in undermanned skills. This thesis analyzes many of the theoretical applications of alternative compensation methods, specifically auctions, signaling theory, and experimental economics; and explains how an economic experiment might be applied within the Department of Defense. This experimental approach presents service members a certain scenario which mirrors a choice they might face when posed with a retention decision. Economic experiments are an inexpensive way to make more informed personnel policy decisions. This thesis postulates that economic experiments are an excellent means to capture the human element in the decision-making process. Additionally, economic experiments provide another form of simulation to "wind-tunnel" test policy changes before implementing them across the services. The sample experiment discussed in this thesis combines the theoretical principles of both auction and signaling theory *and* provides a means to analyze concrete data for which the Department of Defense could use before actually conducting an auction of selective reenlistment bonuses.

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**USING AN EXPERIMENTAL APPROACH TO IMPROVING THE SELECTIVE REENLISTMENT BONUS PROGRAM**

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# ABSTRACT

The Selective Reenlistment Bonus program is a powerful force management tool designed to increase retention in undermanned skills. This thesis analyzes many of the theoretical applications of alternative compensation methods, specifically auctions, signaling theory, and experimental economics; and explains how an economic experiment might be applied within the Department of Defense. This experimental approach presents service members a certain scenario which mirrors a choice they might face when posed with a retention decision. Economic experiments are an inexpensive way to make more informed personnel policy decisions. This thesis postulates that economic experiments are an excellent means to capture the human element in the decision-making process. Additionally, economic experiments provide another form of simulation to "wind-tunnel" test policy changes before implementing them across the services. The sample experiment discussed in this thesis combines the theoretical principles of both auction and signaling theory *and* provides a means to analyze concrete data for which the Department of Defense could use before actually conducting an auction of selective reenlistment bonuses.

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# I.     INTRODUCTION

## A.     PURPOSE AND OBJECTIVES

While the United States military relies heavily on the effective use of technology, weapon systems, and logistics, the most critical component of the military is the individual airmen, soldier, sailor or marine.  All branches of service in the United States military must continue to attract and retain competent personnel.  Therefore, the military must further develop appropriate personnel policies and procedures to maximize the effectiveness of the programs geared toward attracting and retaining those personnel with the necessary and critical skills.

The Department of Defense (DoD) continues to incur increasing costs associated with personnel programs; specifically in the Selective Reenlistment Bonus program. Additionally, in recent fiscal years Congress has appropriated less money than the services have requested for the Selective Reenlistment Bonus program.[1]    While reenlistment bonuses are only a small portion of the military's total manpower expenditures, it is certainly an area that warrants attention because of the enormous impact it can have on service member's individual retention decision.  Consequently, these retention decisions have a direct impact on latter costs the military incurs especially in the areas of education, training, and recruitment.

The Selective Reenlistment Bonus program is a force management tool designed to increase retention in undermanned or poorly retained skills.  The program serves two basic purposes:  to provide incentives to keep existing members in critical skills and to entice other, less critical, skills to retrain into career fields receiving selective reenlistment bonus payments.  In general, each service uses the Selective Reenlistment Bonus program to address poor retention and manpower inventory shortages in critical skills.

There has been a great deal of theoretical research dedicated toward creating new incentives that would effectively attract and retain critical skills in the military.

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[1] United States General Accounting Office, "Military Personnel:  DoD Needs More Effective Controls to Better Assess the Progress of the Selective Reenlistment Bonus Program." GAO-04-86, November 2003, 3.

However, before the DoD can commit to alternative compensation methods, it must thoroughly research how military members might respond to them. The purpose of this thesis is two-fold: it analyzes many of the theoretical applications of alternative compensation methods, specifically auctions and signaling theory; and it explains how an economic experiment might be applied wherein service members respond to a certain scenario which mirrors a choice they might face when posed with a retention decision. Applying this experimental approach will provide the DoD with better information as to how service members respond to these important retention decisions. In turn, the DoD can use this information to determine if the current reenlistment compensation policies warrant change.

## B.      RESEARCH QUESTIONS

Just like many Fortune 500 firms and other large corporations, the DoD must constantly reevaluate and assess the personnel and compensation policies governing incentive packages for service members. Reassessing the current incentive structure allows the DoD the flexibility to better cope with changes in the existing labor market. While it is inconceivable to postulate that there is a "perfect" incentive structure, exploring new avenues will allow the DoD to better compete for and retain its valuable labor resources. This research addresses new avenues to compensate service members.

### 1.      Primary Question

How might a second priced sealed bid auction provide the DoD with a cost effective alternative for calculating enlistment bonuses, while retaining quality military personnel?

### 2.      Secondary Questions

To fully address the primary question, several secondary questions will have to be answered in the development of this thesis. These questions include the relevant issues concerning retention and the current selective reenlistment bonus program; basic compensation practices; potential improvements through different types of auctions;

analysis of economic experiments and the feasibility of incorporating the results into a manageable selective reenlistment bonus program for the DoD.

## C. SCOPE AND LIMITATIONS

This thesis focuses on the broad compensation practices within the DoD. It does not address the specific compensation policies or selective reenlistment bonus programs within each service. While each service has a unique methodology to implementing their respective selective reenlistment bonus program, this research can be applied to all services because it does not interfere with the fundamental goal of the selective reenlistment bonus program; to attract and retain critical skills.

## D. METHODOLOGY

This thesis consists of a literature review that motivates a conceptual model and coupled with a description and justification for an economic experiment to test the model. This thesis uses academic literature to address the possibility of applying auction and signaling theory to alternative compensation practices in the DoD. These theories can then be tested using an economic experiment to predict the possible responses service members may give when faced with a retention decision. While the academic and military communities have conducted a great deal of research on auction and signaling theory, the arena of experimental economics remains yet untapped. The author proposes that through experimental economics the DoD can conduct additional research to capture the human element of a service member's retention decision before implementing an auctioned based approach to reenlistment bonuses.

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# II.   AUCTIONS

## A.   AUCTION DEFINED

Before addressing why the military should study auctions, it is important to first define what an auction is, review some of the terminology related to auctions and discuss the basic types of auctions.  An auction is "a market institution with an explicit set of rules to determine resource allocation and prices based on the bids from market participants."[2]  This definition has three critical elements.  First, an auction is a "market institution."  In other words, an auction is a mechanism or structure where two or more individuals come together.  Second, an auction has "an explicit set of rules to determine resource allocation."  This aspect of the definition implies that the individuals behave under a specific, clear, or detailed set of laws or norms within this market.  Lastly, the "prices (in auctions) are based on the bids of market participants."  Simply stated, the numerical, monetary value of goods or services is based on the offers of the individuals within the market.

## B.   COMMON TERMINOLOGY

Auctions can vary by location, format, or the rules that govern them.  However, as the aforementioned definition highlighted, there are common terms to every auction.  These terms stem from the participants and their respective roles in an auction.  In any auction, these participants are sellers and buyers.  A seller is one who has a good or service that they are willing to provide for a certain price.  The buyer is one seeking to purchase the good or service from the seller.  Often participants are labeled bidders and bid-takers.  A bidder is person or agency competing against one another for the winning price.  A bid-taker is a person or agency that receives the offers submitted by the bidders.

The most familiar auction is one whereby several buyers compete for a good or service that a single seller is willing to provide.  This auction is also known as a forward auction.  The types of goods or services sold in these auctions include, but are not limited to, artwork, antiques, agricultural products, and precious metals.  In a forward auction,

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[2] R. Preston McAfee and John McMillan.  "Auctions and Bidding."  Journal of Economic Literature Vol. XXV, June 1987, 699-738.

the winning bidder is the one who is willing to pay the seller the highest price for the good or service. Another type of auction, the reverse auction, is the inverse of a forward auction. In a reverse auction, a single buyer chooses a good or service from a multitude of sellers. Each seller competes for that one buyer's business and the winner is the seller willing to sell their good or service at the lowest cost to the buyer. Reverse auctions are prevalent in government service or purchasing contracts.

Since in a forward auction there is only one seller, he or she is often labeled a monopolist, because he or she is the sole person (or agency) on that side of the exchange. In a reverse auction, a buyer is often referred to as a monopsonist for the same reason. On the surface it appears that the auction host has an advantage, because they set the rules. However, there are instances where the monopolist or monopsonist might have a disadvantage. As this thesis will later discuss in greater detail, the overarching reason to conduct an auction is based upon an asymmetric information environment. In other words, one party in an exchange of a good or service knows something relevant about the transaction and the other party does not possess the same degree of knowledge.

Information in an auction is crucial, especially when trying to ascertain the value of a good or service that is to be auctioned. The different values bidders place on an item can arise from two specific instances. In the first example, suppose a building contractor is competing against other contractors to build an office park for a corporation. The builder knows precisely how much it will cost him, thus he knows the true value of the contract to him. The building contractor does not know how much the project will cost his competitors; thus he does not know the value they place on the contract. The building contractor can only guess that another bidder's valuation is based on a range of probable values. Similarly, the building contractor knows that the other bidders regard *his* value of the contract to fall within the same range of probable values. This example is called an independent-private-values model, because the value each bidder places on the good or service is independent from any other bidder's valuation.

The second instance where bidders can assign different values is the common value model. The model is often illustrated with the auctioning of an antique. If several dealers bid for an antique, there is a single, accepted value for the antique. That objective

value is the price it will fetch when later purchased from the dealer. In this case, the missing information is the fact that no knows its true value, because that purchase has not happened, yet. Since the dealers have access to different information, they have different guesses as to how much the antique is truly worth. As a result, the dealers will adjust their bid for the antique based on the bids of other dealers.

In the antique example above the value bidders place on the antique is implicit, but bidders have a means of expressing the value they place on the item in the course of the auction by using a reservation price. A reservation price is the price below or above which the bidder is unwilling to go. In other words, in a forward auction, it is the maximum a buyer is willing to pay for an item. The opposite is true in a reverse auction. In a reverse auction, the reservation price is the minimum price a seller is willing to accept for the item. Since auctions rely heavily on information or a lack of information, sellers and buyers must decide whether they should make their reservation price known. This decision is crucial to the design of the auction. If the antique seller announces a reserve price, prospective bidders may focus or center their bids on this price; thus potentially denying the seller the maximum amount of economic rent exchanged in the transaction. Bidders revealing their reservation price may be out-bid by other bidders.

## C.    TYPES OF AUCTIONS

There are four basic types of auctions:  ascending-bid, descending-bid, first-price sealed bid, and second-price sealed bid. Each type differs by location, design, and the set of rules employed. The next section briefly describes these types.

### 1.    Ascending-bid Auctions

The ascending-bid auction is the most commonly recognized type of auction. Ascending-bid auctions are also known as oral, open, or English auctions. In an ascending-bid auction, bidders increase their offered price for a good or service until one bidder pays the proposed price. The bidder that reaches this point wins the good or service and is said to have won the auction. The fundamental principles and rules in an oral auction remain relatively constant. However, the process by which the bidders announce or make their bids known may be vastly different. Some auctions employ an

auctioneer to solicit price increases or declare the current offer. In some auctions, bidders announce their bids aloud or submit them in written form. Other types of ascending-bid auctions may be held electronically. Despite the format used in ascending bid auctions, the bidders know the current high bid for the good or service.

### 2.    Descending-bid Auctions

Descending-bid auctions are also known as Dutch auctions. In a descending-bid auction, an auctioneer proposes an initial price for a good or service. As the auction progresses, the price decreases incrementally until a bidder is willing to pay the price he or she desires and subsequently making this desire known to all auction participants. Descending-bid auctions are similar to ascending-bid auctions in that prospective bidders know the current asking price of the good or service. Dutch auctions originated in the Netherlands when markets would auction cut flowers.[3]

### 3.    First-price Sealed Bid Auctions

In a first-price sealed bid auction, prospective buyers do not know the bids of competing bidders. Bids are sealed with the winning bidder submitting the highest price for the good or service. The good or service is then sold to that buyer at their bid price. The format for first-price sealed bid auctions differs from ascending or descending-bid auctions in two key areas. First, bidders have only one opportunity to submit their bid for the good or service. Second, they have no knowledge about the bids other prospective buyers submit. The Department of Defense and other government agencies use first-price sealed bid auctions in procurement contracts such as privatized housing projects.[4]

### 4.    Second-price Sealed Bid Auctions

Second-price sealed bid auctions are similar to first-price sealed bid auctions. In both types of auctions, bidders submit sealed bids and have no knowledge about the bids of competing buyers. Second-price sealed bid auctions are also known as Vickery auctions. The difference between first and second-price sealed bid auctions is in the price

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[3] R. Preston McAfee and John McMillan. "Auctions and Bidding." Journal of Economic Literature Vol. XXV, June 1987, 699-738.

[4] Ibid.

the winning bidder pays for the good or service.  In first-price sealed bid auctions, the winner submitted the highest bid and paid an amount equal to the bid; thus he or she paid the highest price for the good or service among all competing bidders.  In a Vickery auction, the winning bidder submitted the highest bid, but only paid a price equal to the *second* highest bid for the good or service.  In other words, the winning bidder pays the price that the second place or first losing bidder submitted.

Auction theorists hold that the best or optimal bidding strategy in second-price sealed bid auctions is for participants to submit bids that reflect what they individually perceive as the true value for the good or service.  In practice, however, Vickery auctions are seldom used and participants tend to inflate their bid in an effort to win the good or service while still paying a lower price than the one they submitted.  This thesis purposes an economic experiment to explore this hypothesis.

### D.     COMPARING AUCTIONS

Deciding which of the four types of simple auctions to use can be based on a host of factors.  However, it is important to note that auction theorists conclude:  "each of these auctions forms yields on average the same revenue to the seller."[5]  This statement does not imply that the outcomes of the four auctions are exactly same.  Additionally, although all four types yield the same price on average, there are practical differences.  In both an ascending-bid and a second-price sealed bid auction, the bidder can determine how high they intend to bid.  In an ascending-bid auction, bidders remain in the bidding competition until the price for the good or service reaches his or her perceived value.  In a second-price sealed bid auction, bidders submit bids equal to their perceived value of the good or service.  On the other hand, in a descending bid and first-price sealed bid auction, bidders submit bidders which are *less* than their perceived value.  How much less is dependent upon what each bidder perceives as the range of possible bids competing bidders will submit.  This range is often termed the probability distribution of other bidders.[6]

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[5] Preston McAfee and John McMillan. "Auctions and Bidding." Journal of Economic Literature Vol. XXV, June 1987, 699-738.

[6] Ibid.

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**E.     WHERE AND WHY SHOULD THE MILITARY USE AUCTIONS?**

While the military uses reverse auctions for large purchase contracts, it should use auctions in a variety of other areas and for several important reasons. This section explores alternative applications for auctions in the military, explains these reasons in detail, and discusses some limitations auctions present.

**1.     Alternative Applications**

*a.     Selective Reenlistment Bonuses*

The military can apply reverse auctions to alternative compensation systems such as the Selective Reenlistment Bonus wherein enlisted military members with critical skills sell their labor to a single buyer, the seller's respective branch of service (Army, Navy, Air Force, Marine Corps). An auction of this nature would most certainly require a specific format. Considering that military members are stationed throughout the world, an open auction, even on-line, would be almost impossible. Additionally, such an auction would present numerous technological challenges which may ultimately render the auction cost-prohibitive.

The best format for implementing an auction for the Selective Reenlistment Bonus program would be either a first or second-price sealed bid auction. This format would allow bidders to submit their bid over a set, predetermined time period and give each person the greatest degree of flexibility. A sealed bid auction would allow each service to select the number of personnel that are eligible for reenlistment considering the critical skills needed for any career field with a shortage in those critical skills. The military could, in turn, use this number to determine the number of auction "winners." In a first-price sealed bid auction for selective reenlistments, each service member would receive a bonus equal to the price that he or she bid. This type of auction might result in reenlistment eligible personnel of the same rank and career field receiving different bonuses.

DoD could also implement a second-price sealed bid auction for the selective reenlistment bonus program. Theoretically, a second-price sealed bid auction

would yield the same results (on average). As the buyer, the military would pay the auction winners a bonus equal to the amount that the first losing bid.

### b. *Voluntary Separation Incentive*

Often to meet end strength levels mandated by Congress, the services enact various voluntary separation programs which offer incentives to both officers and enlisted members who voluntarily leave the service. To increase the likelihood of meeting their end strength target, services historically offer an incentive. Just as the Selective Reenlistment Bonus program, an auction under this initiative would require a specific format; most likely a first or second-price sealed bid auction.

### c. *Officer Specialties*

Currently each service offers a bonus to officers in specialized career fields that are undermanned. A few examples include Navy surface warfare officers, Air Force pilots, and Medical Service Corps officers in the Army. Similar to the Selective Reenlistment Bonus program, the military could hold a first or second-price sealed bid auction to retain their desired number of officers in these critically manned career fields.

### 2. Reasons for Implementing Auctions

One reason to use auctions rather than traditional fixed priced methods is because some goods and services do not have a standard value. The military is no different. The value of the individual soldier, sailor, or airmen's labor does not have a standard value. The price for this labor depends on both supply and demand conditions at a specific moment in time. If supply of computer repair technicians in the military is low and the military has a need for computer repair technicians, the price the military is willing to pay for this labor may be high. The reverse is also true. If the supply is high and the demand is low, the price the military is willing to pay for a computer repair technician's labor may be low.

Another reason why the military should implement auctions is because auctions help find the "right" price for a particular good or service. Auctions help find the "right"

price because they set the *minimum* price for those service members who want to be retained. For example in the Selective Reenlistment Bonus program, if a service member bids above what the military (as the buyer) is willing to pay for labor in that critical skill, then the service member would not be retained.

### 3. Auction Limitations

Apart from the technological and logistical challenges they create, auctions have some fundamental limitations. There are instances where auctions may *not* necessarily translate into cost savings. Continuing with the Selective Reenlistment Bonus program example, auctions will not result in significant savings to the military for those who would have reenlisted anyway (without a bonus). The reasoning behind this statement is evident in fact that an auction provides a service member a forum to bid some amount, even if it is small. A service member who would have reenlisted with no bonus, has no incentive to submit a "zero" bid for his or her labor. If given the opportunity, which an auction creates, this person will most certainly submit a positive bid to provide the person with the maximum possible surplus without pricing him or her out of the market.

Another limitation of auctions relates to the information or lack of information garnered from its participants. At the conclusion of an auction, it is difficult to determine the driving factors or forces which cause a buyer or seller to act in a certain manner. Keeping with the Selective Reenlistment Bonus example, an auction does not bring to light any behavioral differences in the auction winners. By way of an auction, if the military were to selectively reenlist only those service members who bid under $10,000, the military would not be able to compare a person who bid $500 against a person who bid up to the $10,000 cap. Because both bidders bid under the reservation price, they both would "win" the auction and thus be reenlisted. However, the difference between these two service members is transparent to the auction process. The military could actively seek this information out via a post-auction survey, but prior to the auction they would have no indication as to how these bidders might behave. The next chapter discusses ways in which the military can combat this information gap.

# III.   SIGNALING

## A.   BACKGROUND

As evident in the previous chapter, one of the fundamental elements of auction theory is the idea that auctions create an environment with asymmetric information.  In the buying and selling of a good or service, one party has better or more information than the other.  One party is informed and the other uninformed.  Often in auctions, sellers do not know how much buyers might be willing to pay for a good or service and buyers do not know what their competitors may be willing to bid.  There is another theory often applied to combating asymmetric transactions:  Signaling Theory.  The premise behind signaling theory states that in an asymmetric environment, there may be other observable indicators of a hidden characteristic which may reveal the informed person's intentions.[7]

There are two ways uninformed parties can gain more information about the informed parties prior to a transaction:  screening and self-selection.  Based on the signals the informed party transmits, uninformed parties in a transaction can set up a device, or screen that sorts the informed parties.  While screening may not reveal the true nature of the informed party's intention, it is one way to differentiate two or more parties so the uninformed party is less uninformed.

The second way uninformed parties can gather more information about informed parties is through a self-selection device.  A self-selection device is "a mechanism in which an informed party…is offered a set of options, and the choice made by the informed party reveals his or her hidden characteristic (or signal)."[8]  This mechanism may be as simple as giving the informed party a choice between two options.  This chapter explores examples of signaling in various markets, limitations of signaling and how the DoD can use signaling to be a more informed decision-maker.

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[7] Michael L. Katz and Harvey S. Rosen. *Microeconomics*, Boston, MA:  The McGraw Hill Compan Ibid.ies, Inc., 1998, 553-591.

[8] Ibid.

## B.    MARKET SIGNALING

### 1.    Labor Market

Michael Spence was one of first theorists to term "market signaling."  In this 1974 book, *Market Signaling:    Information Transfer in Hiring and Related Screening Processes*, Spence noted signaling can be used in the competitive market for labor; specifically between an employer and a prospective employee.  Before hiring a new employee, an employer has little information about the prospective employee on which to base their hiring decision.  This situation creates an environment with asymmetric information with the employer being the uniformed party and the prospective employee being the informed party.  Even after the employee is hired, asymmetric information persists, because an employee's productivity may be unknown to the employer for some time.  Therefore, employers need a better way to distinguish between job applicants.  Spence wrote that employers might base their hiring decision on two factors:  indices and signals.  Indices are characteristics which the prospective employee can not change, such as age and gender.  Signals on the other hand are characteristics which may be controlled by the applicant, but require some "costly action" or investment.[9]

Education is an example of a signal often used in the labor market.  A prospective employee who invests time, effort, and money into his or her education sends a signal to an employer that they possess the necessary skills for employment, because education requires perseverance and a certain degree of intelligence.  These qualities mark a highly productive worker, as well as a successful student.  A person who believes the cost of an education is greater than the benefit it may yield will most likely seek a lower-paying job.  Education is a way prospective employees differentiate themselves and employers can use the information from the signals applicants put forth to make better hiring decisions.

### 2.    Used Car Market

Another market with asymmetric information often used to observe signals is the market for used automobiles.  In his 1970 article "The Market for 'Lemons':  Quality,

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[9] Michael Spence. "Job Market Signaling."  *The Quarterly Journal of Economics* Vol. 87, No. 3, August 1973, 355-374.

Uncertainty, and the Market Mechanism," George Akerlof discussed how a prospective buyer of a used car is an uninformed party and the dealer is the informed party.[10]  In this market, used car buyers cannot distinguish between high and low-quality cars (lemons). While a buyer can get some information by inspecting the car or taking it for a test drive, this is not enough information to accurately determine whether the car is of high or low-quality.  On the other hand, the dealer (seller) has considerably more knowledge about the car.  He knows through experience in the profession and may even have information on the vehicle's history.  Today, dealers send signals to potential buyers in the form of warranties, guarantees, and "certified pre-owned" inspections which convey the message to a buyer that vehicle is not a "lemon."  Buyers perceive these signals to be "costly actions" because the dealer takes time to inspect and money to guarantee the vehicle.  If it is not cost-effective for dealers to guarantee "lemons" the guarantee signals a high-quality car.

### 3.    Life Insurance Market

The life insurance market can also be one with asymmetric information, where the insurance company is the uninformed party and the customer is the informed party. Insurance companies do not know everything about a person's lifestyle and the potential customer may conceal some important information about their lifestyle for fear that they will not receive coverage.  The question then becomes, how can insurance companies get customers to sort or segment themselves so the company can make a better decision? The answer is signaling.  By offering several combinations of premiums and levels of coverage, life insurance companies can gain more information about the customer's lifestyle or behavior.  Potential customers who believe they are relatively safe or engage in less risky behavior will most likely select a low premium and a lower amount of coverage.  Conversely, a customer who has a more risky lifestyle and may engage in risky behavior, such as skydiving, will most likely select a high premium and higher amount of coverage.  Life insurance companies can use these signals to gather more information to aid in their insurance decision, because these signals are "costly actions" by the prospective customer.

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[10] George A. Akerlof.  "The Market for 'Lemons':  Quality, Uncertainty, and the Market Mechanism." *The Quarterly Journal of Economics* Vol 84, No. 3, August 1970, 488-500.

## C.     LIMITATIONS OF SIGNALING

Theorists identify two main problems with signaling theory in markets with asymmetric information:  adverse selection and moral hazard.  Signaling theory helps to mitigate the effect of each problem in an asymmetric information market, but it does not eradicate it altogether.

### 1.      Adverse Selection

Adverse selection occurs when the uninformed party must choose from an undesirable selection or hidden characteristic in the informed party.  This problem arises *before* the transaction takes place.  The example often used to explain adverse selection dilemma is evident in the aforementioned used car market.  Suppose a dealer knows the quality of the car, the buyer does not, *and* the dealer does not disclose this information. Furthermore, the buyer is willing to pay $4,000 for a high-quality used car and $1,000 for a lemon.  Assuming the buyer has a 50% chance of purchasing either type of car, how much would a buyer be willing to pay for a car that has a 50% chance of being a lemon? A reasonable assumption would be the average value of these two types of cars, or $2,500.[11]  Potential buyers base their purchasing decision on this average or expected value.

However, as some sellers of high-quality cars choose not to sell them for $2,500, there will be fewer high-quality cars offered.  Subsequently, the chance of purchasing a high-quality car will decrease and the price will fall.  In a worst case scenario, Akerlof postulated the market would collapse, because no high-quality cars would be offered if the price drops to $1,000.  Buyers would not be able to purchase high-quality cars and dealers would not be able to obtain the true value of a high-quality car.  In other words, the uninformed buyer has to choose from an adverse selection (only "lemons") of the dealer's stock.  It is obvious the market for used cars did not collapse.  Signaling helps combat asymmetric information in this market, but does not eliminate it entirely.

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[11] Arthur O'Sullivan and Steven M. Sheffrin. *Microeconomics:  Principles and Tools*.  3rd ed, Upper Saddle River, NJ:  Prentice Hall, 2003, 311-325.

### 2. Moral Hazard

Signaling does not solve the moral hazard problem created by markets with asymmetric information. This is a problem which occurs *after* an exchange has taken place. The insurance market is often used to illustrate this problem. The moral hazard occurs when an insured person takes an unobserved or hidden action that affects the probability of an event triggering payment by the insurance company. The simplest example is when an insured person participates in reckless driving and this action occurs unbeknownst to the insurance company. This behavior increases the likelihood the insured person will be involved in an accident, which is an event that will trigger payment from the insurance company. To mitigate this problem, insurance companies require deductibles or co-payments in the event of a loss, but this dilemma persists to various degrees in the insurance industry.[12]

## D.    DEPARTMENT OF DEFENSE APPLICATIONS

Just as with job market example outlined at the outset of this chapter, service members send signals to the DoD through their education. In each service, promotion is contingent upon successful completion of various educational programs or levels. Both officers and enlisted personnel complete certain professional military education courses commensurate with their current rank before advancing to the next. Additionally, enlisted members (and some officers) complete job-specific proficiency qualifications throughout the course of their career. Officers may even complete a graduate level program. Service members who successfully complete these programs send a signal to DoD, because they are "costly actions." Completing these educational programs requires a considerable amount of time, effort, and money on the part of the service members. While the services have incorporated these signals into the promotion process, they can also use them to make retention and alternative compensation decisions. Specifically, the DoD can read these signals when establishing a reenlistment bonus.

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[12] Paul G. Keat and Philip K. Y. Young. *Managerial Economics: Economic Tools for Today's Decision Makers*. 4th ed, Upper Saddle River, NJ: Prentice Hall, 2003, 723-731.

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# IV.   EXPERIMENTAL ECONOMICS

## A.   BACKGROUND

Generally speaking, the field of economics is often viewed as an observational science.  Economists develop theories to explain how existing markets act and react in certain conditions and create intricate models to test these theories.   However, the predictive power of these theories and models can be lacking.  As evident in the previous chapters, auction and signaling theories have the advantage of using statistical data and the knowledge gained from existing markets, but even naturally occurring data pose certain challenges. While econometricians are adept at unraveling the effects of key variables of interest, their analysis often can fail to account for "critical tests" of their proposed hypotheses, "because distinguishing historical circumstances might occur only by chance."[13]   Game Theory, a popular field of economic study sparked in the 1970s, relies heavily on behavioral assumptions to make predictions.  Concrete data about this behavior can be lacking or misleading.

Experimental economics, just as other observational sciences (i.e. biology and chemistry) can overcome the problems associated with naturally occurring data by *systematically* collecting data under controlled laboratory conditions.   Economic experiments can be an inexpensive way to study or explain behavior, examine certain economic policies, evaluate performance in institutions, and design better economic incentives.   Moreover, experimentation can demonstrate how a person might behave when faced with an economic choice or identify which economic policies may be ineffective in more complex, naturally occurring environments.

This section discusses several types of economic experiments, design/procedural considerations, and why the DoD should conduct experiments.  By marrying auction and signaling theory with the results of experimental economics, the DoD can make more informed policy decisions.

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[13] Douglas D. Davis and Charles A. Holt.  *Experimental Economics*.  Princeton, NJ:  Princeton University Press, 1993, 3-62.

## B.     TYPES OF EXPERIMENTS

Only recently has the field of experimental economics become prevalent.  While economic theory has a long and distinguished history dating back to the mid-18th century in the works of Adam Smith's *Wealth of Nations*, experimental economics is a relatively recent phenomenon with roots only fifty or sixty years old.  This section is a historical analysis of three types of experiments:  market experiments, game experiments, and individual decision-making experiments.  Almost all economic experiments can be categorized into one or a hybrid of these types.

### 1.     Market Experiments

The first type of economic experiment is a market experiment.  In 1948, Edward Chamberlin used graduate students as subjects in a simulated version of a natural market for one of the first known economic experiments.  In this market, he generated a demand and cost structure by dealing the students a deck of playing cards which were marked with both values and costs.  The cards were indivisible commodities and could be bought or sold.  The cost on each card was the student's reservation price for this commodity.  If they were a buyer, this is the price below which he could profitably buy; if they were a seller, this is the price above which he profitably could sell the card.  Through trading, students could earn hypothetical earnings in two ways:  they could sell a card and earn the difference between the cost and the negotiated price, or they could buy a card and earn the difference between the card's value and the negotiated price.  Students were permitted to freely move around the classroom to negotiate, simulating a free and unregulated market.

Running the experiment forty-six times, Chamberlin recorded the buyers' aggregate reservation prices to determine the market's demand curve and the sellers' aggregate reservation prices formed the market's supply curve (Figure 1).  He remarked that the equilibrium, where price and quantity intersect, in the competitive market "could be established unambiguously and controlled by the experimenter (under only the assumption that buyers and sellers were willing to trade at the reservation prices

established for them in this way)."[14] Chamberlin concluded that outcomes systemically differed from purely competitive market predictions. Specifically, he stated that there were more transactions than the quantity indicated by the equilibrium.
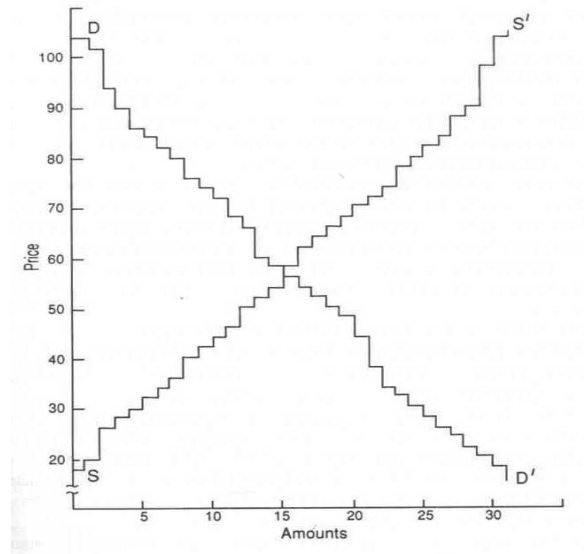


Figure 1.     Induced Supply and Demand Curves (Chamberlin, 1948)

## 2.     Game Experiments

In the 1950s and 1960s, a second type of experiment came into light and remains one of the most popular today among business schools, game theorists, and psychologists. The type of experiment is commonly referred to as "prisoner's dilemma" and was first discussed in Albert W. Tucker's 1950 article, "A Two-person Dilemma." The dilemma is that two people, partners in a crime, are taken into custody, placed in separate interrogation rooms and given the opportunity to confess. For purposes of this example, the partners will be labeled Prisoner A and Prisoner B. If only one prisoner confesses, the other prisoner will receive a seven year jail sentence while the confessing prisoner will serve only one year as an accessory to the crime and for cooperating with the authorities. If neither prisoner confesses, each will receive a two-year sentence. If both confess, each will serve five-year sentences. The figure below (Figure 2) graphically depicts this scenario with the negative numbers representing the time in incarceration and bold text depicts Prisoner B's possible outcomes.

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[14] John H. Kagel and Alvin E. Roth, eds. *The Handbook of Experimental Economics*. Princeton, NJ: Princeton University Press, 1995, 14.

**Prisoner B**

|  | **Confess** | **Don't Confess** |
|---|---|---|
| **Confess** | (-5, **-5**) | (-1, **-7**) |
| **Don't Confess** | (-7, **-1**) | (-2, **-2**) |

Prisoner A

Figure 2.     The Prisoner's Dilemma

Both prisoners would be better off if neither one of them confessed. Each would serve two years. However, since each prisoner is aware of the other's incentive to confess, both "should" confess. In 1983, Andrew Coleman ran over 1,500 experiments of the prisoner's dilemma and sociologists continue to study the factors affecting collaboration, collusion and defection when people make simultaneous decisions in these experiments.[15] Economists apply the prisoner's dilemma to the pricing problem in an oligopoly situation or a market with just a few competing firms where collusion can and does occur.

### 3.     Individual Decision-Making Experiments

The third type of experiment focuses on individual behavior in simple situations and is the most relevant to the DoD, because they are designed to evaluate the choices people make when faced with uncertainty. The roots of the of choice under uncertainty theory came from a work entitled, *Theory of Games and Economic Behavior* by J. von Neumann and O. Morgenstern (1944). Subjects in these experiments make choices between "lotteries" or uncertain outcomes. For example, on the flip of a coin a subject would receive $10.00 for heads and $5.00 for tails. In this experiment, it is clear subjects have a 50% chance of receiving $10.00 and a 50% chance of receiving $5.00. However,

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[15] Douglas D. Davis and Charles A. Holt. *Experimental Economics*. Princeton, NJ: Princeton University Press, 1993, 3-62.

the experimenter would then observe whether subjects would accept additional lotteries with known outcomes as the probability of receiving these outcomes varied.

They concluded it is possible to construct a subject's utility curve or the curve denoting their indifference toward risk and return through these experiments and make predictions about this curve. Not all individual choice experiments are related to this experiment. Other experiments have studied human consumption theory, as well as, varying degrees of rationality in subjects who were asked to forecast market prices.

## C.    DESIGNING EXPERIMENTS

Like experiments in other observational sciences, there are advantages and limitations to conducting experiments in a laboratory. The primary advantages a laboratory environment offers are replicability and control. *Replicability* refers to the capacity of others to reconstruct the same experiment to independently verify the results. *Control* refers to the capacity to change laboratory conditions so that observed behavior can be used to evaluate alternative theories and policies.[16]  It is absolutely essential to consider these elements when designing economic experiments.

One disadvantage commonly cited when conducting laboratory economic experiments relates to the idea that it is difficult to develop alternative hypotheses when examining a primary hypothesis. Usually, establishing a controlled environment provides a test of a particular theory, but testing alternative hypotheses often requires making additional assumptions about an individual or market's behavior.

This section discusses some common terminology used in experiments, some procedural and design considerations in developing experiments and concludes with a few "fatal errors" to avoid when conducting experiments.

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[16] Douglas D. Davis and Charles A. Holt.  *Experimental Economics*.  Princeton, NJ:  Princeton University Press, 1993, 3-62.

## 1.    Common Terminology

Before discussing the intricacies of designing an economic experiment, it is important to identify a few terms which are common to many experiments. These terms were taken from Douglas Davis and Charles Holt's book entitled, *Experimental Economics*. Similar to observational science experiments, the individuals who participate in the experiments are often referred to as **subjects**. The people who administer the experiment are known as **experimenters** or **proctors**. It is important to note that the term "experimenter" usually refers to the person or group of people most responsible for all stages of the experiment's development, its manuscript, its report, etc; the term "proctor" refers to the person or group of people that simply administers the experiment, but these terms are often used interchangeably.

Every experiment is based on a number of sessions or rounds. A **session** is a sequence of decision tasks involving the same groups of subjects on the same day. Participants are often gathered and analyzed as a **cohort**, or a group of subjects that participated in a session. Experiments apply **treatment** variables. These are unique factors which affect the environment or configuration, such as incentives, experience, information and rules. Applying the same experimental treatment variables to a set of sessions is referred to as a **cell**. A collection of sessions used to evaluate economic propositions in one or more related cells is an **experiment**.

## 2.    Procedural and Design Considerations

Davis and Holt also classify procedural and design considerations for conducting economic experiments into categories that are commonly accepted in experimental economic literature. These categories are as follows: procedural regularity, motivation, unbiasedness, calibration, and design parallelism. This section briefly discusses these categories.

### a.    *Procedural Regularity*

Procedural regularity focuses on the ability for independent verification and the experimenter's data collection methodology and ability to effectively report the results. The most critical element of an experiment is the final report of analysis. Reports should include the set of instructions given to subjects. Instructions should test a

subject's understanding of the experiment, include criteria for answering questions, discuss the nature of incentives, and have a practice run with no reward. Reports should also include: the subject pool, methods of recruiting, the number and experience level of subjects, and a discussion of the physical laboratory environment, location, dates, and duration of sessions. Reports should highlight any procedural deviations in specific sessions warranting interpretation and any intentional deception of subject members. Standardization is the key to establishing procedural regularity. Many experiments incorporate visually isolated computer terminals or cubicles to present instructions or conduct a session.

### b. *Motivation*

Another important design consideration is motivation. Participants should receive rewards which correlate to the incentives outlined in the experiment. Usually these rewards are in the form of monetary payments versus hypothetical dollars, because providing actual monetary rewards reduces performance variability in the results.[17] Prior to conducting a session, the experimenter should fully explain the incentive structure in the instructions. To bolster subject recruitment, often economic experiments use participation or "sitting" fees in addition to the rewards distributed.

### c. *Unbiasedness*

The experiment should not shade subjects to respond in a certain manner. It is essential subjects believe that the experimenters are not expecting a certain response or that there is a correct answer. Subjects can perceive suggestive terminology in the instructions or incentive structure as subtle behavioral suggestions to respond in a certain way. For example, auctions that bid for abstract good or services are preferred over "natural gas permits." Biased data collection procedures can easily invalidate a session's results or the entire experiment.

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[17] Sidney Siegel and D.A. Goldstein. "Decision-making Behavior in a Two-Choice Uncertain Outcome Situation." *Journal of Experimental Psychology*, Vol. 57, 1959, 37-42.

### d.	Calibration

When designing experiments, it critical to have a clear basis of comparison.  If a market experiment tests how competitive behavior is altered by a treatment variable, such as the market power in the hands of only one seller, then the experiment should set a "baseline" condition.  This experiment should begin with a baseline condition in which competitive transactions are created in the *absence* of this market power.[18]  Another aspect of calibration can relate to the choices presented to subjects.  Choices should be clearly delineated and understood.  For example, many experiments call for subjects to make choices under uncertain conditions.  Subjects have a 75% chance of receiving outcome A and 25% chance of receiving outcome B.  In this situation, presenting subjects with obtuse probabilities, such as .63 for outcome A and .125 for outcome B, is not recommended.

### e.	Design Parallelism

The last consideration is design parallelism or the need for experiments to accurately reflect naturally occurring economic situations.  Laboratory experiments attempt to simplify economic situations.  While they are not mirror images of naturally occurring conditions, markets or events, they should relate to these natural settings.  A key element of design parallelism relates to the appropriate amount of information subjects receive.  For example, auction experiments in which buyers and sellers do not know the costs and values of other bidders can provide an excellent way to uncover behavioral facts in a realistic environment.

### 3.	Critical Errors

Procedural errors in experiments can produce inconsistent results.  Some errors can be fatal causing the results to be worthless to the observer or analyst.  Biased or incomplete instructions can cripple an experiment.  Failing to use salient financial rewards is another critical error.  Some experiments try to test too many variables.

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[18] Douglas D. Davis and Charles A. Holt.  *Experimental Economics*.  Princeton, NJ:  Princeton University Press, 1993, 3-62.

Experimenters should focus on a few treatments which do not change too many things at once.[19] Avoiding these common mistakes requires a detailed plan and can be overcome prior to the start of the experiment.

## D.    WHY SHOULD THE MILITARY CONDUCT EXPERIMENTS?

The most obvious reason the DoD should conduct economic experiments is cost. Experiments are an inexpensive way to make more informed policy decisions. Although the *concept* of cost has been and continues to be a driving factor in many DoD decisions, the current methodology employed by the DoD does not accurately reflect the total cost to the military; specifically, the intrinsic costs a service member incurs throughout the course of their career. Identifying intrinsic costs requires the DoD to study humans and human behavior. The *primary* reason to conduct experiments is because they capture the human element.

While there are countless components to the human element of decision making, two of the most important to the DoD are risk aversion and probability estimation. Economic experiments that analyze a person's aversion to risk have limitless applications to the military. The DoD may want to better understand why certain people enter or leave the service or volunteer for "risky" career fields. Economic experiments form a bridge between the uncertainty many recruiting models create and the concrete data of human behavior. The second facet of the human element is related to probability estimation. While humans may conceptually understand choices under uncertainty, their behavior is not indicative of the uncertainty a situation presents.

For example, a service member may have a 75% chance of being promoted to the next rank. She may fully understand her chances of promotion, because she knows to some extent how she compares to others. She may be told by her supervisor and chain of command that she has 75% chance, she may study the promotion rates of past promotion boards, but she may not *behave* as if she has a 75%. She may behave as if she had only a 50% chance of being promoted based on her job performance and productivity. Understanding how people behave when faced with uncertainty is extremely valuable to

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[19] Douglas D. Davis and Charles A. Holt. *Experimental Economics*. Princeton, NJ: Princeton University Press, 1993, 3-62.

the DoD, because they can make better policy decisions. With the knowledge, in the previous example, the DoD might place a greater emphasis on productivity for promotion.

Besides capturing the human element, economic experiments are another form of simulation. Laboratory experiments create mechanisms in an environment where humans make decisions similar to those in the real world. In 2002, Vernon Smith received the Nobel Prize for his work in experimental economics. He was recognized for developing "wind-tunnel tests" for new, alternative markets. Smith tested the effects of deregulating the electricity market in a laboratory before being implemented. The DoD spends a great deal of time and money testing many of its weapon systems. If the DoD were to embrace economic experiments, they could "wind-tunnel test" many policy changes before implementing them across the services. The next chapter of this thesis provides an example of one such test.

# V. APPLYING A SECOND-PRICE SEALED BID EXPERIMENT

## A. BACKGROUND

Using the procedural and design considerations discussed in the previous section as a template, this chapter explains in detail an example of an individual decision-making economic experiment for conducting a second-price sealed bid auction. This section incorporates many of the principles and theories discussed in the auction, signaling and experimental economics chapters of this thesis. The entire experiment may be found in the appendices (Appendices A-E).

The purpose of this experiment is to test whether it is possible to find, if presented a choice, some unseen dimension which will cause a service member to reveal the value each person places on employment outside the military. The aforementioned choice is based on similar choices service members face when presented with retention decisions. While this choice in the experiment is not military-specific by design, it is intended to simulate the decisions a service member would make under uncertain conditions.

The experiment has two main parts: Initial Salary Survey and Second Salary Survey. The next section gives an overview of each part. In 2007, Dr. Peter Coughlan and Dr. William Gates of the Naval Postgraduate School's Graduate School of Business and Public Policy designed this experiment with the assistance of Captain Chandria Dietrich, United States Air Force.

### 1. Initial Salary Survey

In the first part of the experiment (Appendix A), subjects will make a choice under the uncertain employment conditions of Firm A. Subjects are given a scenario in which they are one of one hundred employees working in Firm A. Their only other potential employer is Firm B. They also have no preference for either firm. In other words, the subject can easily switch employers at no cost or inconvenience to them. Additionally, they are told that no matter where they end up working, they will be retiring in five years. Subjects are instructed of their goal; to maximize their total income for the next five years.

Next, subjects are presented information about their current employer (Firm A) and the uncertain employment conditions. Firm A is going to downsize over the next five years and will begin laying off 10% of its workforce or 10 out of the 100 employees. Firm A will lay off additional employees in future years, but the exact number is uncertain initially. Also, Firm A will not hire any new employees during these five years. Subjects are instructed that if they leave or are laid off from Firm A, there will be no opportunity to return to Firm A.

Firm B has offered to employ anybody who leaves Firm A immediately or in future years. Since Firm B is the only other employment opportunity for the subjects., they can leave Firm A now and work for Firm B over the next five years *or* leave Firm A after one, two, three or four years and subsequently work for Firm B for the remainder of the five years. Firm B presents a confidential annual salary offer to each employee of Firm A and the subjects do not know the salary amount that Firm B has offered to other employees of Firm A. Subjects do know these salary amounts are spread evenly and random across some range, but they do not know the highest or lowest salary (upper and lower bounds) in this range. The example at Appendix A shows the salary offered to one subject is $90,000, but this number may be changed or randomized when actually conducting the experiment. Additionally, subjects are told neither Firm A nor Firm B will raise or cut salary levels over the subsequent five year period.

In the last section of the initial salary survey, subjects submit an annual salary request to Firm A and receive the rules for submitting it. Firm A is asking each of its 100 employees to specify the minimum annual salary each subject would need to receive to remain at Firm A. Firm A will then pay the minimum salary necessary to voluntarily retain 90 of its 100 employees for the next year. In other words, after Firm A collects all 100 salary requests, it will "lay off" the 10 employees who submitted the highest salary requests. The 10 employees who were laid off will immediately work for Firm B at the salary previously offered. The remaining 90 employees will work at Firm A at least one more year and will be paid the same salary, regardless of the amount they requested.

The remaining 90 employees will be paid the lowest salary which was requested among the 10 employees that were laid off. Restated, Firm A will pay all remaining

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employees the 10th highest salary requested. By design, this part of the experiment is intended to mirror the procedures of a second-price sealed bid auction where bidders submit sealed bids (salary requests) and have no knowledge about the competing bidders. In this experiment the bidders are the sellers, selling their labor to a single buyer, Firm A. The final step of the initial survey asks subjects to enter their annual salary request.

### 2. Second Salary Survey

After the initial salary survey, subjects receive one of two possible outcomes. Either the salary they request is one of the ten highest salaries *or* the salary they request is not one of the ten highest. If the salary they request is one of the ten highest, then they will be directed to the instructions outlined at Appendix B. These instructions reveal the highest and lowest salary requests (upper and lower bounds) of the other employees of Firm A and the 10th highest salary request. Since the subject submitted a salary request at or above this amount, the subject (employee) will not be retained by Firm A and will receive Firm B's offer of $90,000 over the next five years. Thus, their total income is $450,000 (5 years X $90,000).

If the subject's salary request is not of the ten highest salaries, then they will be directed to the instructions at Appendix C. These instructions also reveal the highest and lowest salary requests of the other employees of Firm A and the 10th highest salary request. Because the subject submitted a salary request below this amount, Firm A retains the employee for one year.

In the initial survey, subjects were informed Firm A would make additional lay offs in future years. The second part of the experiment presents another level of uncertainty. The uncertainty stems from the subject's estimation in the number of employees Firm A will lay off in the next four years. To mitigate confusion, subjects are provided this estimation. The sample experiment (Appendix C) instructs subjects that they estimate Firm A will lay off 30% of its employees in each of the next four years. Conversely, the probability that the subject will be retained in *any* future year is 70%. Additionally, Firm A will randomly select which employees are laid off in future years.

Next, subjects receive a set of instructions that assists them in calculating what their "expected" annual salary would be using the aforementioned 30% estimate. Subjects are given a table with five possible patterns of employment. Table 1 below shows these possibilities.

| | Pattern 1 Firm A for 1 Year | Pattern 2 Firm A for 2 Years | Pattern 3 Firm A for 3 Years | Pattern 4 Firm A for 4 Years | Pattern 5 Firm A for 5 Years |
|---|---|---|---|---|---|
| *Probability of Pattern:* | **30%** | **21%** | **15%** | **10%** | **24%** |
| *Year 1 Employer Firm:* | A | A | A | A | A |
| *Year 2 Employer Firm:* | B | A | A | A | A |
| *Year 3 Employer Firm:* | B | B | A | A | A |
| *Year 4 Employer Firm:* | B | B | B | A | A |
| *Year 5 Employer Firm:* | B | B | B | B | A |

Table 1.     Patterns of Employment Using 30% Estimated Workforce Reduction in Firm A

While subjects are certain to work for Firm A for at least one year, this table shows that there are actually five possible patterns of employment over the next five years. Specifically, subjects can be laid off from Firm A after one, two, three or four years, or could remain with Firm A for the entire five year period. These probability patterns correspond to subject's original estimation that Firm A will be reduced by 30% per year over the next five years. Using these probability patterns, the 10th highest salary from Firm A, and the salary previously offered by Firm B, subjects are shown how to calculate their expected annual salary, which is a weighted average of their annual salary given these probabilities.

As an alternative to the uncertainty, Firm A will give a five year employment guarantee to half (50%) of its retained employees. To determine which employees will be offered this guarantee, Firm A will conduct another salary survey. This survey will determine: which of the 90 retained employees will be guaranteed employment with Firm A for the next five years *and* the annual salary these 45 people will be paid.

In the second survey, Firm A asks each of the 90 retained employees to specify the minimum annual salary that he or she would need to receive in order to remain with Firm A for the next five years. After collecting all the 5-year salary requests from its 90 retained employees, Firm A will give a 5-year employment guarantee to the 45 employees who submit the lowest 5-year annual salary request. The 45 employees who submit the highest 5-year annual salary request will *not* receive the guarantee.

The 45 employees give a 5-year guarantee will each be paid the lowest 5-year annual salary requested by the 45 employees *not* given the guarantee. In other words, the 45 employees given a 5-year guarantee will each be paid the 45th highest 5-year annual salary request submitted in the second survey. For those that do not receive the guarantee, the terms of employment with Firm A will remain unchanged. They will work at least one year for Firm A. At this point, subjects submit their 5-year annual salary request.

Just as in the initial salary survey subjects receive one of two possible outcomes. Either their second salary request is in/above the 50th percentile (or among the 45 highest) of salary requests *or* their request is below the 50th percentile (or among the 45 lowest) of salary request. If their request is in/above the 50th percentile, then they will be directed to the information contained at Appendix D, which lists the upper and lower bounds of the requests submitted and the 45th highest 5-year annual salary request among all employees of Firm A. Subjects are informed that they will not be given one of the 5-year employment guarantees. Additionally, subjects receive their total income based on one of the five probable patterns of employment. The experiment can assign these patterns randomly.

If their request is below the 50th percentile, then they will be directed to the information contained in Appendix E, which also lists the upper and lower bounds of the requests submitted and the 45th highest 5-year annual salary request among all Firm A employees. Since their request is not among the 45 highest 5-year annual salary requests, they will be guaranteed employment for the next five years in Firm A. Additionally, subjects receive their total income based on the 45th highest 5-year annual salary request.

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## B.    DESIGN AND PROCEDURAL CONSIDERATIONS

Before conducting this experiment, it is important to consider the procedural and design considerations discussed in experimental economic literature.    This section explains these areas in detail, but the experimenter should also ensure the overarching principles of control and replicability are closely followed.    Developing a clear set of instructions in advance will help maintain control in the laboratory environment as well as establish a solid basis for others to replicate the experiment.

### 1.    Procedural Regularity

As the previous chapter noted, standardization is the key to procedural regularity. The instructions given to subjects should test a subject's understanding of the experiment, include criteria for answering questions, discuss the nature of incentives and include a trial run with no reward.    Any procedural deviations should be noted and thoroughly explained.    Establishing procedural regularity does not stop with the instructions. Experimenters need to conduct each session in the same manner.    By design the experiment should include 21 - 31 rounds.    The one to three rounds would be the trial or practice runs without an incentive to tests the subjects' understanding of the experiment without penalty.    In the next two rounds, subjects would be rewarded.

In the initial salary survey (Appendix A), Firm B offers a confidential salary offer.    To prevent subjects from seeing others' offer or how other subjects may respond during the session, this experiment should be conducted in a controlled laboratory environment.    This experiment is computer-based.    Therefore, selecting a facility with visually isolated computer terminals is important to effectively control the experiment. Additionally, the experimenter should arrive before the start of each session to ensure subjects do not discuss any aspect of the experiment.

Experimenters should consider using additional personnel (proctors) to control entry into the facility or room.    Proctors can provide subjects instructions which prohibit discussion during the session.    Before each session, proctors should collect relevant demographic data on each subject.    Since this experiment tests a service member's individual decisions, recording their name, gender, rank, branch of service, number of

years in service, and career field (i.e. Military Occupation Specialty, Designator, or Air Force Specialty Code) are beneficial to the analysis. Furthermore, proctors should collect each subject's contact information for additional experiments or verification of responses.

### 2.    Motivation

This experiment uses "experimental income" as its incentive. Subjects seek to maximize their total experimental income over the five year period. After their responses, their total experimental income is converted into actual earnings at a $100,000 to $1 exchange rate. For example, the sample experiment at Appendix B shows the subject received $450,000 in total experimental income for the five year period. This subject would receive $4.50 in actual earnings. While this exchange rate may be adjusted based on the experimenter's budgetary constraints, it is important that subjects receive "actual" earnings as opposed to some hypothetical reward. As noted in the previous chapter, a monetary reward reduces variability in the responses and increases a subject's attentiveness during the instructions phase of the session.

The promise of real money is a strong motivator in this experiment. However, motivation also involves recruiting subjects. Recruiting efforts should be well publicized and advertised to ensure maximum participation. Experimenters can advertise the fact that participants will receive a monetary reward, but should use caution to ensure they do not reveal too much information about the experiment. If recruiting a sufficient number of subjects proves challenging, experimenters should consider implementing a sitting or participation fee. If more subjects arrive than the facility can accommodate, proctors should ensure potential subjects provide their contact information for future sessions. Experimenters can also request subjects sign up in advance.

Time can also be a motivating factor. The instructions and advertisements need to state approximately how long each session will last. In its current form, the author estimates this experiment will need one hour to complete 21 - 31 sessions; one practice round followed by two rounds with monetary rewards. Future experimenters may need to adjust this estimate.

### 3.     Unbiasedness

It should be emphasized that at no point do the instructions refer to the survey as an auction or refer to the military in any way.  The experiment is intentionally ambiguous on these issues to maintain control and not shade subjects to respond in a certain manner.  Likewise, any advertisement or verbal instructions should be equally ambiguous.  Additionally, the experiment is gender and rank neutral.  Ideally to obtain the most unbiased results, the experiment should be administered to both officers and enlisted personnel while not in a military uniform.  Rank on a military uniform can be a distraction in a session.  However, if separate sessions are the only means of conducting a session, experimenters should note this fact in their report of analysis.  To remain unbiased, the sample experiment also intentionally avoids the terms "contracts" or "enlistments" so subjects do not respond in a certain way.

### 4.     Calibration

The most malleable feature of this experiment is how it calibrated.  While subjects face some degree of uncertainty in the current experiment, there are additional opportunities to test other treatment variables.  For example, in Appendix C subjects are provided the calculation for determining their expected annual income.  Additional experiments could test whether subjects understand the concept of probability or expected income in future years by *not* providing this information.  Intentionally omitting this information creates additional uncertainty.  Future experiments could analyze the subjects' responses with this added uncertainty.  However, experimenters should not change too many treatments at once.  The current experiment establishes a base of comparison for additional experiments, because it is a relatively simple type of an individual decision-making experiment.

### 5.     Design Parallelism

While this experiment creates a hypothetical economic scenario, a choice between staying at Firm A or working for Firm B, the decisions subjects make are quite similar to retention decisions military members face today.  Reenlistment eligible service members weigh employment in the military against the uncertain probability of working for a

civilian firm. Furthermore, with the United States Navy and Air Force recently facing end strength cuts, those service members eligible for involuntary separation face similar uncertain retention decisions. This experiment is one way the DoD can analyze how service members make these retention decisions.

## C. CONCLUSION AND RECOMMENDATIONS FOR FURTHER STUDY

Currently, all branches of the armed forces employ various models to selectively attract and retain critical skills based on force-shaping needs. They routinely adjust the bonus levels to retain the required number of personnel. However, these bonus levels seldom nominally decline. Over time, service members perceive these bonuses as part of their normal pay and allowances. While these programs are moderately successful in achieving force structure goals through forecasting, they can be fiscally inefficient because they do not have a means to determine how much service members would be willing to accept to remain in that critical skill. Everyone is paid an equal amount. By design, the DoD selective reenlistment bonus programs lack the ability for service members to signal their intentions and communicate their willingness to continue service. Creating a mechanism or means for service member to signal their intentions is essential to the DoD's long-term personnel policy and force structure decisions.

By itself, an auction to determine the selective reenlistment bonus would undoubtedly generate the quantity of service members needed in a particular critical skill. However, an auction would not provide any insight as to the quality of service members in that critical skill. Creating a device for service members to signal their intentions will give the DoD some insight into the quality of service members. Separately these theories are not beneficial to the DoD. It is imperative these theories be incorporated together.

This sample experiment does just that *and* provides concrete data for analysis which the DoD could use before actually conducting an auction of selective reenlistment bonuses. For example, if each of the services publicized (separately) the maximum amount they would be willing to pay for labor in a particular critical skill, service members would be likely to change their behavior with respect to their bidding strategy. Prior to an auction, if the services publicized the number of short and long-term

guarantees it was going to offer in a particular critical skill, services members would behave differently compared to a situation which offered an unlimited number of long-term guarantees. This sample experiment provides the DoD a means to study the human element of decision-making. In other words, it gives the DoD a way to study how and to what degree a service member's behavior changes.

However, the most important piece of information the DoD can glean from this sample experiment is based on the premise that this experiment will cause service members to reveal the value they place on employment outside the military. It is well known that service members behave differently among the various branches of the armed forces. Additionally, within each branch, service members with the same critical skills behave differently. They also place different values on their labor in and outside the military. This experiment gives the DoD some insight into the value service members place on this labor, because the choice to remain at Firm A is made under uncertain conditions.

Analyzing future economic experiments will help the DoD make a more informed decision regarding the implementation of alternative compensation practices. Experiments are a powerful means to conduct an inexpensive feasibility study. If the "wind-tunnel" test of a second-price sealed bid auction does not produce the results postulated in this thesis, then the DoD should choose not to implement this alternative compensation practice. However, if the DoD is able to gain some insight into the value service members place on employment outside the military and subjects signal their intentions for continued service, then this experiment is can provide sound data which will help in the decision to adopt an alternative compensation practice for the Selective Reenlistment Bonus program.

# APPENDIX A.  SECOND-PRICE SEALED BID AUCTION INDIVIDUAL CHOICE EXPERIMENT INITIAL SALARY SURVEY

**Scenario Background**
You are 1 of 100 employees currently working for Firm A.
Your only other potential employer is Firm B.
You have no particular preference for Firm A or for Firm B.
You can easily switch employers at no cost or inconvenience to you.
No matter where you end up working, you will be retiring 5 years from now.
Your only goal for the next 5 years is to maximize your total income over that time span.

**Downsizing at Firm A**
Firm A will be downsizing over the next 5 years.
Firm A will begin by laying off 10% of its workforce immediately (10 out of 100 employees).
Firm A will lay off additional employees in future years, but the exact number is uncertain at this time.
Firm A will not be hiring any new employees (or rehiring laid off or departed employees) during this period.
Thus, if you choose to leave or are laid off from Firm A, there will be no opportunity to return to Firm A in later years.

**Employment Offer from Firm B**
Firm B has offered to employ anybody who leaves Firm A, whether they leave now or in later years.
If you leave Firm A now, you will work at Firm B for the next 5 years.
If you leave Firm A after year 1, 2, 3, or 4, you will work for Firm B for the remainder of the 5 year period.
This standing offer of employment at Firm B applies whether you leave Firm A voluntarily or are laid off.

**Salary Offer from Firm B**
Firm B has presented a confidential annual salary offer to each employee currently working for Firm A.
The offer presented to each employee represents the annual salary that he/she will receive if employed by Firm B.
Firm B has offered different annual salary amounts to different Firm A employees.
For each year that you work for Firm B, Firm B has offered to pay you the following annual salary:

**$90,000**

**Distribution of Salary Offers from Firm B**
You do <u>not</u> know the salary amounts that Firm B has offered to other current employees at Firm A.
You know only that all of Firm B's salary offers are spread evenly and randomly over some range.
In other words, these salary offers are spread evenly & randomly between some lower bound & some upper bound.
You do not know the actual lower and upper bounds of the range of salary offers.
However, you do know that the salary offered to you by Firm B lies somewhere within this range of offers.
Thus, it is safe to assume that some of Firm B's salary offers to potential employees are higher than your offer above.
It is also safe to assume that some of Firm B's salary offers to potential employees are lower than your offer.

**Future Salary Changes**
Over the next 5 years, each employee's annual salary will only change if he/she changes employers.
In other words, Firm A will pay you the same annual salary for each year that you work there (no salary raises or cuts).
Similarly, Firm B will pay you the same annual salary for each year that you work there (no salary raises or cuts).
The annual salary that you receive at the two different firms, however, may be different.

**Salary Survey at Firm A**
The salary paid to any Firm A employee in previous years will have no influence on his/her future salary at Firm A.
Instead, the annual salary that Firm A will be pay to each of its retained employees will be determined using a survey.
Firm A is asking each of its 100 workers to specify the minimum annual salary that he/she would need to receive in order to remain with Firm A.

Firm A will then pay the minimum salary necessary to voluntarily retain 90 of its 100 employees for next year.
In particular, after collecting all 100 "salary requests" from its employees, Firm A will lay off the 10 employees who submitted the highest salary requests.
Each of the 10 employees laid off will immediately begin working at Firm B at the salary previously offered.
The remaining 90 employees will work at Firm A for at least one more year.
All employees retained by Firm A will be paid the same salary, regardless of the salary they requested.
These retained employees will be paid the lowest salary that was requested among the 10 employees laid off.
In other words, Firm A will pay all retained employees the 10th highest salary requested.
Note that this salary will be as high or higher than the salary requested by any of the 90 retained employees.

**Your Salary Request to Firm A**
You must now decide what annual salary to request from Firm A.
Remember that if your request is among the highest 10 of the 100 salary requests submitted, you will be laid off from Firm A and will work for Firm B for the next 5 years at the salary offer above.
If your salary request to Firm A is <u>not</u> among the 10 highest, you will continue to work for Firm A for at least one more year and will receive an annual salary equal to the lowest salary requested among the 10 employees not retained.
What annual salary do you request from Firm A:

*Salary Request to Firm A:* **$145,000**

PROCEED

# APPENDIX B. SECOND-PRICE SEALED BID AUCTION
# INDIVIDUAL CHOICE EXPERIMENT - ABOVE 90<sup>TH</sup> PERCENTILE

*IF SALARY REQUEST IS ABOVE 90TH PERCENTILE OF THE DISTRIBUTION:*

**Distribution of Salary Requests to Firm A**
The *lowest* annual salary request submitted to Firm A by one of its other current employees was: **$40,000**
The *highest* annual salary request submitted to Firm A by one of its other current employees was: **$100,000**
The *10th highest* annual salary request submitted to Firm A by one of its current employees was: **$142,466**

**Your Employer, Salary, and Income for the Next 5 Years**
Your salary request was among the 10 highest requests submitted to Firm A.
Therefore, you will not be retained by Firm A and will instead be employed by Firm B for the next 5 years.
Each year, you will receive the annual salary offered to you by Firm B previously.
Thus, your income over the next 5 years will be as follows:

| | |
|---|---|
| *Year 1:* | $90,000 |
| *Year 2:* | $90,000 |
| *Year 3:* | $90,000 |
| *Year 4:* | $90,000 |
| *Year 5:* | $90,000 |
| | |
| ***Total:*** | **$450,000** |

The total above is your experimental earnings for this period.
This total will be converted to actual earnings from participation in this experiment at the exchange rate of
$100,000 of experimental income = $1 of actual earnings

Please wait until instructed to do so before clicking on the button below.

> **Proceed**

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# APPENDIX C.  SECOND-PRICE SEALED BID AUCTION INDIVIDUAL CHOICE EXPERIMENT - BELOW 90<sup>TH</sup> PERCENTILE

*IF SALARY REQUEST IS BELOW 90TH PERCENTILE OF THE DISTRIBUTION*

**Distribution of Salary Requests to Firm A**
The *lowest* annual salary request submitted to Firm A by one of its other current employees was:  **$40,000**
The *highest* annual salary request submitted to Firm A by one of its other current employees was: **$100,000**
The *10th highest* annual salary request submitted to Firm A by one of its current employees was: **$142,466**
Recall that this 10th highest salary request is the lowest request submitted among the 10 employees not retained.

**Your Employer and Salary for the Next Year**
Your salary request was <u>not</u> among the 10 highest requests submitted to Firm A.
Therefore, you will be retained by Firm A for the next year.
Your salary for this first year will be equal to the 10th highest salary request submitted to Firm A as given above.

**Future Lay Offs at Firm A**
Firm A will continue to reduce the size of its workforce in future years.
You estimate that Firm A will lay off the following percentage of its employees in each of the next 4 years:
**30%**
Employees laid off from Firm A in future years will be selected at random.
Thus, the percentage listed above is also the probability that you will be laid off from Firm A in any given year.
Conversely, the probability that you will be <u>retained</u> by Firm A in any future year is equal to:
**70%**

**Your Employer in Future Years**
Remember that if you are ever laid off from Firm A, you will be immediately employed by Firm B.
While you are certain to work for Firm A for at least the next year, you actually have 5 different possible patterns of employment over the next 5 years.
In particular, you could be laid off from Firm A after 1, 2, 3, or 4 years, or you could remain with Firm A for the entire 5 year period.
Each of these 5 patterns of employment and its associated probability is illustrated below:

|  | Pattern 1 Firm A for 1 Year | Pattern 2 Firm A for 2 Years | Pattern 3 Firm A for 3 Years | Pattern 4 Firm A for 4 Years | Pattern 5 Firm A for 5 Years |
|---|---|---|---|---|---|
| *Probability of Pattern:* | **30%** | **21%** | **15%** | **10%** | **24%** |
| *Year 1 Employer Firm:* | A | A | A | A | A |
| *Year 2 Employer Firm:* | B | A | A | A | A |
| *Year 3 Employer Firm:* | B | B | A | A | A |
| *Year 4 Employer Firm:* | B | B | B | A | A |
| *Year 5 Employer Firm:* | B | B | B | B | A |

**Your Salary in Future Years**
Each year that you are employed by Firm B, you will earn the annual salary previously offered to you by Firm B.

Thus, each of the 5 patterns of employment illustrated above has an associated pattern of annual salaries:

| | Pattern 1 Firm A for 1 Year | Pattern 2 Firm A for 2 Years | Pattern 3 Firm A for 3 Years | Pattern 4 Firm A for 4 Years | Pattern 5 Firm A for 5 Years |
|---|---|---|---|---|---|
| **Probability of Pattern:** | **30%** | **21%** | **15%** | **10%** | **24%** |
| | | | | | |
| *Year 1 Salary:* | $142,466 | $142,466 | $142,466 | $142,466 | $142,466 |
| *Year 2 Salary:* | $90,000 | $142,466 | $142,466 | $142,466 | $142,466 |
| *Year 3 Salary:* | $90,000 | $90,000 | $142,466 | $142,466 | $142,466 |
| *Year 4 Salary:* | $90,000 | $90,000 | $90,000 | $142,466 | $142,466 |
| *Year 5 Salary:* | $90,000 | $90,000 | $90,000 | $90,000 | $142,466 |
| | | | | | |
| *Total 5 Year Income:* | $502,466 | $554,932 | $607,398 | $659,864 | $712,330 |
| *Annual Average:* | $100,493 | $110,986 | $121,480 | $131,973 | $142,466 |

**Your Expected (or Weighted Average) Annual Salary**
As shown above, your average annual salary over the next 5 years could end up being any one of 5 different amounts.
To determine the annual salary you can expect (on average) during this period, you must calculate a weighted average.

The weighted average salary is calculated using the following two steps:
   (1) Multiply each of the 5 possible annual average salaries by the probability of that particular pattern occurring.
   (2) Sum these values over all 5 possible employment patterns.

In other words, your weighted average (or expected) annual salary is given by the following formula:

**Weighted Average Annual Salary = $Prob_1$ x $Avg_1$ + $Prob_2$ x $Avg_2$ + $Prob_3$ x $Avg_3$ + $Prob_4$ x $Avg_4$ + $Prob_5$ x $Avg_5$**

Using the values from the first and last rows of the previous chart, your expected average salary is thus:
**$119,099**

**Possibility of a 5 Year Employment Guarantee with Firm A**
As noted previously, your employment with Firm A (and the associated salary) is currently guaranteed only for 1 year.
Your employer (and thus, your salary) in later years is uncertain with each possibility analyzed mathematically above.
As an alternative to this uncertainty, Firm A will give a 5 year employment guarantee to half of its retained employees.

**Another Salary Survey at Firm A**
To determine which employees will be offered 5 year employment, Firm A will conduct another salary survey.
This second survey will be conducted among only those 90 employees retained after the first salary survey.
This second salary survey will determine:
   (1) which of the 90 retained employees will be guaranteed employment with Firm A for the next 5 years;
   (2) the annual salary that will be paid to each of these 5 year employees.

In this second survey, Firm A is asking each of its 90 retained employees to specify the minimum *annual* salary that he/she would need to receive in order to remain with Firm A for the next 5 years.
Firm A will then determine the minimum 5-year annual salary necessary for 45 of its 90 retained employees to voluntarily remain with Firm A for 5 years.

In particular, after collecting all the 5-year salary requests from its 90 retained employees, Firm A will give a 5 year guarantee of employment to the 45 employees who submitted the *lowest* 5-year annual salary requests.

The remaining 45 employees (those who submit the highest 5-year annual salary requests) will <u>not</u> receive a 5 year guarantee of employment.

The 45 employees given a 5 year guarantee of employment will each be paid the lowest 5-year annual salary that was requested among the 45 employees <u>not</u> given a 5 year employment guarantee.

In other words, the 45 employees given a 5 year guarantee of employment will each be paid the *45th highest* 5-year annual salary request that was submitted in the second salary survey.

For the 45 employees <u>not</u> guaranteed 5 year employment, the terms of employment with Firm A will remain unchanged.

In your case this means that if you are not guaranteed 5 year employment with Firm A:
   (1) You will still be guaranteed employment with Firm A for at least 1 year.
   (2) The probability that they will be laid off from Firm A in any year after the first is still equal to: **30%**
   (3) Your annual salary during any year that you are employed by Firm A will still be equal to: **$142,466**
   (4) If you ever laid off from Firm A, you will be employed by Firm B for the remainder of the 5 year period.
   (5) Your annual salary during any year that you are employed by Firm B will still be equal to: **$90,000**

**Your Second Salary Request to Firm A**
You must now decide what 5-year guaranteed annual salary to request from Firm A.

Remember that if your request is among the highest 45 of the 90 salary requests submitted, you will be laid off from Firm A and will work for Firm B for the next 5 years at the salary offer above.

Remember that if your 5-year annual salary request is among the lowest 45 requests in this second survey:
   (1) You are guaranteed to work for Firm A for 5 years.
   (2) You will be paid the 45th highest 5-year annual salary requested in this second survey.

If your salary request to Firm A is <u>not</u> among the 45 lowest, you will receive the previously determined annual salary for as long as you work for Firm A, but you will only be guaranteed employment at Firm A for the first year.

What 5-year guaranteed annual salary do you request from Firm A:

*5-Year Annual Salary Request to Firm A:*     **$135,000**

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# APPENDIX D.  SECOND-PRICE SEALED BID AUCTION INDIVIDUAL CHOICE EXPERIMENT SECOND SALARY SURVEY – ABOVE 50<sup>TH</sup> PERCENTILE

*IF SECOND SALARY REQUEST IS ABOVE 50TH PERCENTILE OF THE NEW DISTRIBUTION:*

**Distribution of New Salary Requests to Firm A**
The *lowest* 5-year annual salary request submitted among the other Firm A employees was:  **$40,000**
The *highest* 5-year annual salary request submitted among the other Firm A employees was: **$100,000**
The *45th highest* 5-year annual salary request submitted among all Firm A employees was:   **$130,867**

**Your Terms of Employment for the Next 5 Years**
Your salary request was among the 45 highest requests submitted to Firm A.
Therefore, you will <u>not</u> be given a 5 year guarantee of employment with Firm A.
Instead, you are only guaranteed to work for Firm A for one year.
At the end of each year with Firm A, the probability that you are laid off from Firm A is equal to:  **30%**
If you are ever laid off from Firm A, you will work for Firm B for the remainder of the 5 year period.
Each year that you work for Firm A, your annual salary will be:                    **$142,466**
Each year that you work for Firm B, your annual salary will be:                    **$90,000**

**Your Actual Employer, Salary, and Income for the Next 5 Years**
In this section, your employer and salary for each of the next 5 years is determined based on the probability of being laid off from Firm A each year.
Your actual employer in each of the next 5 years is as follows:

| | |
|---|---|
| *Year 1:* | FIRM A |
| *Year 2:* | FIRM A |
| *Year 3:* | FIRM B |
| *Year 4:* | FIRM B |
| *Year 5:* | FIRM B |

Thus, your annual salary and total income over the next 5 years is as follows:

| | |
|---|---|
| *Year 1:* | $142,466 |
| *Year 2:* | $142,466 |
| *Year 3:* | $90,000 |
| *Year 4:* | $90,000 |
| *Year 5:* | $90,000 |
| *Total:* | **$554,932** |

The total above is your experimental earnings for this period.
This total will be converted to actual earnings from participation in this experiment at the exchange rate of $100,000 of experimental income = $1 of actual earnings

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# APPENDIX E.  SECOND-PRICE SEALED BID AUCTION INDIVIDUAL CHOICE EXPERIMENT SECOND SALARY SURVEY – BELOW 50<sup>TH</sup> PERCENTILE

*IF SALARY REQUEST IS BELOW 50TH PERCENTILE OF THE NEW DISTRIBUTION:*

**Distribution of New Salary Requests to Firm A**
The *lowest* 5-year annual salary request submitted among the other Firm A employees was:  **$40,000**
The *highest* 5-year annual salary request submitted among the other Firm A employees was: **$100,000**
The *45th highest* 5-year annual salary request submitted among all Firm A employees was:   **$129,517**

**Your Employer, Salary, and Income for the Next 5 Years**
Your salary request was among the 45 lowest requests submitted to Firm A.
Therefore, you will be guaranteed employment with Firm A for the next 5 years.
Each year, you will receive the 45th highest annual salary requested in the second survey which is indicated above.
Thus, your income over the next 5 years will be as follows:

| | |
|---|---|
| *Year 1:* | $129,517 |
| *Year 2:* | $129,517 |
| *Year 3:* | $129,517 |
| *Year 4:* | $129,517 |
| *Year 5:* | $129,517 |
| | |
| ***Total:*** | **$647,586** |

The total above is your experimental earnings for this period.
This total will be converted to actual earnings from participation in this experiment at the exchange rate of $100,000 of experimental income = $1 of actual earnings

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